Journal of Visualization, Vol. 11, No. 4 (2008) 280

Portfolio Paper

Breathing Blunt Nose for Drag Reduction at Hypersonic Speeds

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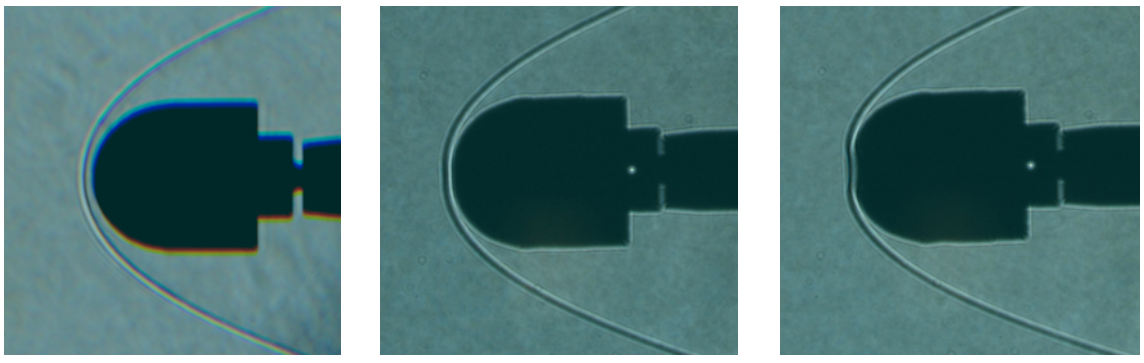
Received 25 June 2008



(a) (b) (c)

Fig. 1. Shock wave at the nose of a blunt nosed body at Mach 7 flow, (a) nose without hole, (b) nose with 5 mm hole and (c) nose with 10 mm hole.

A new concept termed Breathing Blunt Nose (BBN) was proposed by Rathakrishnan for drag reduction and heat dissipation at hypersonic flow regimes. In the BBN technique, flow is allowed to pass through a small hole in the nose of a blunt nosed body and made to come out through the base. Because of the relief offered by the breathing, the strength of the bow shock is reduced as the flow passes through the hole at the nose. This reduces the value of positive C_p at the nose. The high pressure flow, traversed by the shock at the nose is injected into the suction zone at the base. The high pressure flow discharged at the base reduces the suction, resulting increase of base pressure (decrease of negative C_p). Due to these processes, a significant reduction in the drag on the body is anticipated. The additional advantage of the breathing mechanism is that, the heat generated at the body surface due to skin friction is convected away by the air which flows over the inner surface. Since it is a kind of passive technique, there is no need for additional energy. The first set of tests with BBN was conducted at Mach 7 in the hypersonic tunnel at the Department of Advance Energy, Graduate School of Frontier Sciences, University of Tokyo. The typical result shows 10 % drag reduction achieved with BBN. The shock at the nose of a blunt nosed body in Mach 7 flow was visualized with shadowgraph technique. The shock at the nose without breathing hole and with 5 mm and 10 mm diameter breathing holes are shown in Figs. 1(a), (b) and (c), respectively. It is seen that the bow shock wave became more curved with breathing. That is the shock at the nose is made weaker. Also, for 10 mm hole, the middle portion of the shock is deflected towards the hole.